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COMPUTATION OF BROADBAND MIXING NOISE FROM TUBOMACHINERY

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During this reporting period we have completed a paper entitled "Discretization errors inherent in finite difference solution of propeller noise problems" to be presented at the AIAA 13th Aeroacoustics Conference. This paper discusses the phenomena of dispersion and spurious acoustic radiation in calculating propeller noise using finite difference approximation. Dispersion effect here is global in nature and could cause large distortion of the radiated acoustic waveform as the waves propagate away from the propeller.

We have also completed a study of the approximate radiation boundary condition for the Helmholtz equation. The Helmholtz equation is obtained from the wave equation by separating out the time periodic factor. One of the better known radiation boundary conditions for the Helmholtz and the acoustic wave equation was established by Bayliss and Turkel using the asymptotic solution of the partial differential equation. We performed computational experiments to test the effectiveness of the Bayliss-Turkel radiation boundary condition. The pertinent parameter in the numerical experiments was the number of mesh points per acoustic wave length. When a relatively large number of mesh points per wave length was used, e.g. 15 or more, it was found that the Bayliss-Turkel radiation boundary condition was nearly transparent with very little reflection. However, when the number of mesh points per wave length was small, say 5, then there was a total breakdown of the Bayliss-Turkel radiation boundary condition. The reflected wave was so large in amplitude that the computed solution for the case of a simple source bore no resemblance to the exact analytical solution. We have since devised a new radiation boundary condition based not on the asymptotic solution of the partial differential equation but on the governing difference equation. This improved radiation boundary condition has been found to be transparent even when 5 mesh points per wave length was used in the computation. This work including an analysis and numerical experiment on the effect of an isotrophy has now been completed. It is in the process of being written up for journal publication.